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(54) POWER STORAGE SYSTEM AND SELF-STARTING METHOD THEREFOR

ENERGIESPEICHERSYSTEM UND SELBSTSTARTVERFAHREN DAFÜR

SYSTÈME DE STOCKAGE D'ÉNERGIE ET PROCÉDÉ D'AUTO-DÉMARRAGE ASSOCIÉ

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Description

TECHNICAL FIELD

[0001] The present invention relates to the field of energy storage technologies, and in particular, to an energy storage system and a self-start method thereof.

BACKGROUND

[0002] In a joint energy storage application scenario, energy of an energy storage system comes from solar and wind energy, and after being converted into electric energy by an energy conversion device, is supplied to a grid for use or stored in an energy storage system for storage.

[0003] At present, in a design of an energy storage system, if energy input from solar and wind energy cannot meet power consumption of the system itself, the energy storage system cannot be started, resulting in that externally available power held by the energy storage system cannot be normally output.

[0004] References KR 10 2015 0 081 987 A and KR 10 2015 0 138 900 A disclose energy storage systems of the generic kind.

SUMMARY

[0005] In view of this, embodiments of the present invention provide an energy storage system and a self-start method thereof, to resolve a prior-art problem that an energy storage system cannot self-start when there is no external power supply.

[0006] The invention is defined in the appended claims.

BRIEF DESCRIPTION OF DRAWINGS

[0007] To describe the technical solutions of the present disclosure more clearly, the following briefly describes the accompanying drawings required for describing the embodiments.

FIG. 1 is a schematic diagram of an optional energy storage system; and
FIG. 2 is a flowchart of a self-start method.

DETAILED DESCRIPTION

[0008] Power conversion system: Power Conversion System, PCS for short;

PV: Photovoltaic, photovoltaic;
MBMU: Master Battery Management Unit, master battery management unit;
SBMU: Slave Battery Management Unit, slave battery management unit;
DC/DC: DC conversion module, configured to convert high voltage direct current into low voltage direct current, for example, converting about 400-volt direct current into 24-volt direct current; and
CSC: Cell Supervisor Circuit, cell supervisory circuit.

[0009] FIG. 1 is a schematic diagram of an energy storage system. The energy storage system includes n single racks. Due to a size of the figure, FIG. 1 shows the first single rack and the n^{th} single rack, components of other n-2 single racks and a connection relationship between the components are similar to those of the first single rack and the n^{th} single rack.

[0010] Denotations of numbers in FIG. 1 are as follows:

10: DC bus;
20: main isolation switch;
101: first miniature circuit breaker of the first single rack;
102: second miniature circuit breaker of the first single rack;
103: wake-up relay of the first single rack;
104: main positive high voltage relay of the first single rack;
105: main negative high voltage relay of the first single rack;
106: release of the first single rack;
107: release relay of the first single rack;
108: high voltage precharge relay of the first single rack;
109: isolation switch of the first single rack;
110: circuit breaker of the first single rack;
111: fuse of the first single rack;
112: diode of the first single rack;
113: precharge resistor of the first single rack;
n01: first miniature circuit breaker of the n^{th} single rack;
n02: second miniature circuit breaker of the n^{th} single rack;
n03: wake-up relay of the n^{th} single rack;
n04: main positive high voltage relay of the n^{th} single rack;
n05: main negative high voltage relay of the n^{th} single rack;
n06: release of the n^{th} single rack;
n07: release relay of the n^{th} single rack;
n08: high voltage precharge relay of the n^{th} single rack;
n09: isolation switch of the n^{th} single rack;
n10: circuit breaker of the n^{th} single rack;
n11: fuse of the n^{th} single rack;
n12: diode of the n^{th} single rack; and
n13: precharge resistor of the n^{th} single rack.

[0011] The power conversion system PCS is based on photovoltaic PV or wind energy. The host computer may be an industrial computer, a touchscreen, a PC, or the like.

[0012] As shown in FIG. 1, the energy storage system includes a power conversion system, a DC bus, n single racks, a host computer, and a master battery management unit, n is a natural number, and n is greater than 1.

[0013] The host computer is connected to each of the n single racks.

[0014] The master battery management unit is connected to each of the n single racks.

[0015] Each of the n single racks includes a first miniature circuit breaker, a DC/DC power module, a slave battery management unit, a wake-up relay, a main positive high voltage relay, a main negative high voltage relay, a CSC module, and a battery box, where the first miniature circuit breaker is connected to both the DC/DC power module and the battery box, the wake-up relay is connected to each of the DC/DC power module, the slave battery management unit, and the CSC module, the DC/DC power module is connected to each of the first miniature circuit breaker, the wake-up relay, and the slave battery management unit, the main positive high voltage relay is connected to the battery box, and the main negative high voltage relay is connected to the battery box. When the power conversion system PCS has no power input:

a single rack, meeting a preset condition, of the energy storage system is determined first. For example, the preset condition may be voltage being highest, or voltage being greater than specified voltage. It is assumed that the single rack, meeting the preset condition, of the energy storage system is a single rack b, a first miniature circuit breaker of the single rack b is closed, and a DC/DC power module of the single rack b receives power from a battery group (the battery group is located in a battery box), and outputs the power to the master battery management unit, the host computer, and a slave battery management unit of the single rack b.

[0016] The slave battery management unit of the single rack b controls a wake-up relay of the single rack b to be closed, so that CSC-b1 to CSC-bm modules (a CSC module of the single rack b) start to work after being awakened, thereby completing start-up of the single rack b.

[0017] Through the host computer, the single rack b is controlled to be powered on at high voltage (that is, a main positive high voltage relay of the single rack b and a main negative high voltage relay of the single rack b are closed), the DC bus is controlled to be energized, and the PCS is controlled to be energized.

[0018] For other single racks, the k^{th} single rack is used as an example. A DC/DC power module of the k^{th} single rack receives power from the DC bus and outputs the power to a slave battery management unit of the k^{th} single rack.

[0019] The slave battery management unit of the k^{th} single rack controls a wake-up relay of the k^{th} single rack to be closed, so that CSC-k1 to CSC-km modules (a CSC module of the k^{th} single rack) start to work after being awakened, thereby completing start-up of the k^{th} single rack.

[0020] The PCS controls the k^{th} single rack to complete high voltage power-on (that is, a main positive high voltage relay of the k^{th} single rack and a main negative high voltage relay of the k^{th} single rack are closed).

[0021] After high voltage power-on, a system operator manually opens the first miniature circuit breaker of the single rack b. At this point, the energy storage system completes self-start and is powered by a battery.

[0022] When the power conversion system has no power input, the target single rack, meeting the preset condition, of the energy storage system is determined, and the first miniature circuit breaker of the target single rack is closed. The DC/DC power module of the target single rack receives power from a battery group and outputs the power to the master battery management unit, the host computer, and the slave battery management unit of the target single rack. The slave battery management unit of the target single rack controls the wake-up relay of the target single rack to be closed, so that the CSC module of the target single rack starts to work after being awakened, thereby completing start-up of the target single rack. Through the host computer, the target single rack is controlled to be powered on at high voltage, the DC bus is controlled to be energized, and the PCS is controlled to be energized. The PCS controls other single racks to complete high voltage power-on. This resolves the prior-art problem that an energy storage system cannot self-start when there is no external power supply, and implements that the energy storage system self-starts without an external power supply.

[0023] Optionally, each of the n single racks further includes a release and a release relay. The release relay is connected to each of the slave battery management unit, the DC/DC power module, and the release.

[0024] Functions of the release and the release relay are to open the first miniature circuit breaker of the single rack.

[0025] The PCS controls the single racks to complete high voltage power-on in sequence. After high voltage power-on is successfully completed, the system operator needs to manually open the first miniature circuit breaker of the single rack b. At this point, the energy storage system completes self-start and is powered by a battery.

[0026] When the system operator forgets to manually open the first miniature circuit breaker of the single rack b, the slave battery management unit of the single rack b continuously performs detection on a switching status of the first miniature circuit breaker of the single rack b. If it is detected that the first miniature circuit breaker of the single rack b is not opened, after a period of time (the time may be set based on a specific application scenario), the slave battery management unit of the single rack b controls a release relay of the single rack b to be closed. After being energized, a release of the single rack b performs an action of opening the first miniature circuit breaker of the single rack b. If the first miniature circuit breaker of the single rack b is still in a closed state after the release action, alarm information is sent to instruct the system operator to perform troubleshooting.

[0027] Optionally, each of the n single racks further includes a second miniature circuit breaker. One end of the second miniature circuit breaker is connected to the power conversion system, and the other end of the second miniature circuit breaker is connected to the DC/DC power module.

[0028] Optionally, the system further includes a main isolation switch. One end of the main isolation switch is connected to the power conversion system, and the other end of the main isolation switch is connected to each of the n single racks.

[0029] Optionally, each of the n single racks further includes a circuit breaker and an isolation switch. One end of the circuit breaker is connected to the main isolation switch, and the other end of the circuit breaker is connected to the isolation switch. One end of the isolation switch is connected to the circuit breaker, and the other end of the isolation switch is connected to both the main positive high voltage relay and the main negative high voltage relay.

[0030] The isolation switch has four poles. A first pole is connected to the main positive high voltage relay, a second pole is connected to a first pole of the circuit breaker, a third pole is connected to the main negative high voltage relay, and a fourth pole is connected to a third pole of the circuit breaker.

[0031] The circuit breaker has four poles. The first pole is connected to the second pole of the isolation switch, a second pole is connected to a fourth pole of the main isolation switch, the third pole is connected to the fourth pole of the isolation switch, and a fourth pole is connected to a third pole of the main isolation switch.

[0032] The first miniature circuit breaker has four poles. A first pole is connected to a positive electrode of the battery box, a second pole is connected to a diode, a third pole is connected to a negative electrode of the battery box, and a fourth pole is connected to the DC/DC power module. The fourth pole is further connected to a third pole of the second miniature circuit breaker.

[0033] The second miniature circuit breaker has four poles. A first pole is connected to a diode, the third pole is connected to the fourth pole of the first miniature circuit breaker, and one of a second pole and a fourth pole is connected to a positive electrode of the PCS, and the other one is connected to a negative electrode of the PCS. In addition, the second pole is connected to a second pole of the main isolation switch, and the fourth pole is connected to a first pole of the main isolation switch. It should be noted that the diode connected to the second pole of the first miniature circuit breaker is not a same diode as the diode connected to the first pole of the second miniature circuit breaker.

[0034] The main isolation switch has four poles. The first pole is connected to each of fourth poles of second miniature circuit breakers of the n single racks, the second pole is connected to each of second poles of the second miniature circuit breakers of the n single racks, the third pole is connected to each of fourth poles of circuit breakers of the n single racks, and the fourth pole is connected to each of second poles of the circuit breakers of the n single racks. In addition, one of the first pole and the second pole is connected to the positive electrode of the PCS, and the other one is connected to the negative electrode of the PCS.

[0035] Optionally, each of the n single racks further includes a high voltage precharge relay and a precharge resistor. The high voltage precharge relay is connected in series with the precharge resistor, and then the high voltage precharge relay and the precharge resistor in series connection are connected in parallel with the main positive high voltage relay.

[0036] Optionally, each of the n single racks further includes a fuse. One end of the fuse is connected to the main positive high voltage relay, and the other end of the fuse is connected to the battery box.

[0037] In a process of controlling high voltage power-on of the single rack, first the main negative high voltage relay is closed, then the high voltage precharge relay is closed, and then the main positive high voltage relay is closed, and finally the high voltage precharge relay is opened. An advantage of doing so is to prevent other components of the single rack from being damaged by excessive current in the process of high voltage power-on.

[0038] For example, in a process of controlling high voltage power-on of a single rack k, first a main negative high voltage relay of the single rack k is closed, then a high voltage precharge relay of the single rack k is closed, and then a main positive high voltage relay of the single rack k is closed, and finally the high voltage precharge relay of the single rack k is opened.

[0039] When a single rack x triggers over-discharge protection, a slave battery management unit of the single rack x first controls a main positive high voltage relay and a main negative high voltage relay of the single rack x to be opened, and then controls a wake-up relay of the single rack x to be opened. CSC-x1 to CSC-xm modules (a CSC module of the single rack x) stop working after a wake-up signal disappears, so that the single rack x exits a system, but other single racks and the system work normally, thereby implementing protection for the single rack.

[0040] FIG. 2 is a flowchart of a self-start method of an energy storage system. This method is applied to the foregoing energy storage system. As shown in FIG. 2, the method includes the following steps.

[0041] Step S 100. Close a first miniature circuit breaker of a target single rack, so that a DC/DC power module of the target single rack is energized and outputs power to a master battery management unit, a host computer, and a slave battery management unit of the target single rack, where the target single rack is a single rack, meeting a preset condition, of the energy storage system.

[0042] Step S200. The slave battery management unit of the target single rack controls a wake-up relay of the target single rack to be closed, so that a CSC module of the target single rack starts to work after being awakened, thereby completing start-up of the target single rack.

[0043] Step S300. Control, through the host computer, the target single rack to be powered on at high voltage, a DC bus to be energized, and a power conversion system to be energized.

[0044] Step S400. A DC/DC power module of a k^{th} single rack receives power from the DC bus, and outputs the power to a slave battery management unit of the k^{th} single rack, where k is a natural number between 1 and n, and the k^{th} single rack is any single rack of the energy storage system except for the target single rack.

[0045] Step S500. The slave battery management unit of the k^{th} single rack controls a wake-up relay of the k^{th} single rack to be closed, so that a CSC module of the k^{th} single rack starts to work after being awakened, thereby completing start-up of the k^{th} single rack. Before the energy storage system is started, a main isolation switch, n circuit breakers (110 to n10 in FIG. 1), n isolation switches (109 to n09 in FIG. 1), and n second miniature circuit breakers of the energy storage system (102 to n02 in FIG. 1) are all closed.

[0046] The following describes a self-start process of the energy storage system in two scenarios.

Scenario 1: The power conversion system PCS has power input.

[0047] A single rack 1 is used as an example to describe a start-up process of a single rack. A DC/DC power module of the single rack 1 receives power from the PCS, and outputs the power to the master battery management unit, the host computer, and a slave battery management unit of the single rack 1. The slave battery management unit of the single rack 1 controls a wake-up relay of the single rack 1 to be closed, so that CSC-11 to CSC-bm modules (a CSC module of the single rack 1) start to work after being awakened, thereby completing start-up of the single rack 1. Other single racks complete start-up following a same process. After being started, the energy storage system is powered by the power conversion system PCS.

Scenario 2: The power conversion system PCS has no power input.

[0048] A single rack, meeting a preset condition, of the energy storage system is determined first. For example, the preset condition may be voltage being highest, or voltage being greater than specified voltage. It is assumed that the single rack, meeting the preset condition, of the energy storage system is a single rack b, a first miniature circuit breaker of the single rack b is closed, and a DC/DC power module of the single rack b receives power from a battery group (the battery group is located in a battery box), and outputs the power to the master battery management unit, the host computer, and a slave battery management unit of the single rack b.

[0049] The slave battery management unit of the single rack b controls a wake-up relay of the single rack b to be closed, so that CSC-b1 to CSC-bm modules (a CSC module of the single rack b) start to work after being awakened, thereby completing start-up of the single rack b.

[0050] Through the host computer, the single rack b is controlled to be powered on at high voltage (that is, a main positive high voltage relay of the single rack b and a main negative high voltage relay of the single rack b are closed), the DC bus is controlled to be energized, and the PCS is controlled to be energized.

[0051] For other single racks, the k^{th} single rack is used as an example. A DC/DC power module of the k^{th} single rack receives power from the DC bus and outputs the power to a slave battery management unit of the k^{th} single rack.

[0052] The slave battery management unit of the k^{th} single rack controls a wake-up relay of the k^{th} single rack to be closed, so that CSC-k1 to CSC-km modules (a CSC module of the k^{th} single rack) start to work after being awakened, thereby completing start-up of the k^{th} single rack.

[0053] The PCS controls the k^{th} single rack to complete high voltage power-on (that is, a main positive high voltage relay of the k^{th} single rack and a main negative high voltage relay of the k^{th} single rack are closed).

[0054] After high voltage power-on, a system operator manually opens the first miniature circuit breaker of the single rack b. At this point, the energy storage system completes self-start and is powered by a battery.

[0055] When the power conversion system has no power input, the target single rack, meeting the preset condition, of the energy storage system is determined, and the first miniature circuit breaker of the target single rack is closed. The DC/DC power module of the target single rack receives power from a battery group and outputs the power to the master battery management unit, the host computer, and the slave battery management unit of the target single rack. The slave battery management unit of the target single rack controls the wake-up relay of the target single rack to be closed, so that the CSC module of the target single rack starts to work after being awakened, thereby completing start-up of the target single rack. Through the host computer, the target single rack is controlled to be powered on at high voltage, the DC bus is controlled to be energized, and the PCS is controlled to be energized. The PCS controls other single racks to complete high voltage power-on. This resolves the prior-art problem that an energy storage system cannot self-start when there is no external power supply, and implements that the energy storage system self-starts without an external power supply.

[0056] In an optional implementation, the self-start method of the energy storage system further includes step S600 in addition to steps S100 to S500.

[0057] Step S600. The slave battery management unit of the target single rack performs detection on a switching status of the first miniature circuit breaker of the target single rack; if it is detected that the first miniature circuit breaker of the target single rack is not opened, after preset time, the slave battery management unit of the target single rack controls a release relay of the target single rack to be closed; and after the release is energized, a release of the target single rack performs an action of opening the first miniature circuit breaker of the target single rack.

[0058] Functions of the release and the release relay are to open the first miniature circuit breaker of the single rack.

[0059] The PCS controls the single racks to complete high voltage power-on in sequence. After high voltage power-on is successfully completed, the system operator needs to manually open the first miniature circuit breaker of the single rack b. At this point, the energy storage system completes self-start and is powered by a battery.

[0060] When the system operator forgets to manually open the first miniature circuit breaker of the single rack b, the slave battery management unit of the single rack b continuously performs detection on a switching status of the first miniature circuit breaker of the single rack b. If it is detected that the first miniature circuit breaker of the single rack b is not opened, after a period of time (the time may be set based on a specific application scenario), the slave battery management unit of the single rack b controls a release relay of the single rack b to be closed. After being energized, a release of the single rack b performs an action of opening the first miniature circuit breaker of the single rack b. If the first miniature circuit breaker of the single rack b is still in a closed state after the release action, alarm information is sent to instruct the system operator to perform troubleshooting.

[0061] In an optional implementation, the self-start method of the energy storage system further includes step S700 in addition to steps S100 to S600.

[0062] Step S700. When an x^{th} single rack triggers over-discharge protection, a slave battery management unit of the x^{th} single rack first controls a main positive high voltage relay of the x^{th} single rack and a main negative high voltage relay of the x^{th} single rack to be opened, and then controls a wake-up relay of the x^{th} single rack to be opened, where the x^{th} single rack is any single rack of the energy storage system.

[0063] When a single rack x triggers over-discharge protection, a slave battery management unit of the single rack x first controls a main positive high voltage relay and a main negative high voltage relay of the single rack x to be opened, and then controls a wake-up relay of the single rack x to be opened. CSC-x1 to CSC-xm (a CSC module of the single rack x) stop working after a wake-up signal disappears, so that the single rack x exits a system, but other single racks and the system work normally, thereby implementing protection for the single rack.

[0064] Black start of the energy storage system is implemented (that is, self-start of the energy storage system is completed without an external power supply). If the energy storage system includes a plurality of single racks, a single rack with highest voltage of the energy storage system is properly selected as a power supply source for black start of the energy storage system. This can achieve a specific balance effect.

Claims

1. An energy storage system, wherein the system comprises:

    a power conversion system, PCS, for converting electrical energy from photovoltaic, PV, or wind energy;
    a DC bus connected to the PCS for energizing the PCS;
    n single racks, wherein n is a natural number, and n is greater than 1;
    a host computer, connected to each of the n single racks; and
    a master battery management unit, MBMU" connected to each of the n single racks, wherein
    each of the n single racks comprises a first miniature circuit breaker (101, n01), a DC/DC power module, a slave battery management unit, SBMU, a wake-up relay (103, n03), a main positive high voltage relay (104, n04), a main negative high voltage relay (105, n05), a cell supervisory circuit, CSC, module, and a battery box including a battery group and comprising a positive and a negative electrode,
    wherein in each of the n single racks:

        the DC/DC power module is connected to the DC-Bus (10) for receiving power from the DC-Bus (10)
        the DC/DC power module is connected to the battery group included in the battery box via the first miniature circuit breaker (101, n01) and is configured to receive power from the battery group when the first miniature circuit breaker (101, n01) is closed;
        the DC/DC power module is connected to the SBMU, the host computer and the MBMU and is configured to provide power to each of them when the DC/DC power module receives power from the battery group included in the battery box via the closed first miniature circuit breaker (101, n01),
        the SMBU, when receiving power from the DC/DC power module, being configured to close the wake-up relay (103, n03) for connecting the DC/DC power module to the CSC module via the wake-up relay (103, n03) for providing power to the CSC;
        the main positive high voltage relay (104, n04) is connected to the positive electrode

of the battery group included in the battery box, and the main negative high voltage relay (105, n05) is connected to the negative electrode of the battery group included in the battery box, wherein the host computer, when receiving power from the DC/DC power module, being configured to close the main positive voltage relay (104, n04) and the main negative voltage relay (105, n05), and wherein the battery box is configured to to provide power to the DC-Bus via the closed main positive voltage relay (104, n04) and the closed main negative voltage relay (105, n05).

2. The system according to claim 1, wherein each of the n single racks further comprises:

a release (106, n06); and
a release relay (107, n07), connected to each of the DC/DC power module and the release (106, n06), wherein the release relay is controllable by the slave battery management unit (SBMU) to be closed, and wherein the release is configured to perform an action of opening the first miniature circuit breaker (101, n01) when the release relay is closed under control of the (SBMU).

3. The system according to claim 1, wherein each of the n single racks further comprises:
a second miniature circuit breaker (102, n02), one end of which is connected to the power conversion system (PCS), and the other end of which is connected to the DC/DC power module.

4. The system according to any one of claims 1 to 3, wherein the system further comprises:
a main isolation switch (20), one end of which is connected to the power conversion system, and the other end of which is connected to each of the n single racks.

5. The system according to claim 4, wherein each of the n single racks further comprises:

a circuit breaker (110, n10), one end of which is connected to the main isolation switch (20), and the other end of which is connected to an isolation switch (109, n09); and
the isolation switch (109, n09), one end of which is connected to the circuit breaker (110, n10), and the other end of which is connected to both the main positive high voltage relay (104, n04) and the main negative high voltage relay (105, n05).

6. The system according to claim 5, wherein each of the n single racks further comprises:
a high voltage precharge relay (108, n08) and a precharge resistor (113, n13), wherein the high voltage precharge relay (108, n08) is connected in series with the precharge resistor (113, n13), and then the high voltage precharge relay (108, n08) and the precharge resistor (113, n13) in series connection are connected in parallel with the main positive high voltage relay (104, n04).

7. The system according to claim 1, wherein each of the n single racks further comprises:
a fuse (111, n11), which is interconnected into the connection between the main positive high voltage relay (104, n04) and the positive electrode of the battery group included in the battery box.

8. A method to self-start an energy storage system according to claim 1, wherein the method comprises:

closing the first miniature circuit breaker (10, n01) of a target single rack, so that the DC/DC power module of the target single rack is energized and outputs power to the master battery management unit, MBMU, the host computer, and the slave battery management unit, SBMU, of the target single rack, wherein the target single rack is a single rack, meeting a preset condition, of the energy storage system;
controlling, by the SBMU of the target single rack, a wake-up relay (103, n03) of the target single rack to be closed, so that the cell supervisory circuit, CSC, module of the target single rack starts to work after being awakened, thereby completing start-up of the target single rack;
controlling, through the host computer, the main positive high voltage relay (104, n04) and the main negative high voltage relay (105, n05) to be closed so that the target single rack gets powered on at high voltage, making the DC bus (10) to be energized, and the power conversion system, PCS, to be energized;
receiving, by the DC/DC power module of a k^{th} single rack, power from the DC bus (10), and outputting the power to the SBMU of the k^{th} single rack, wherein k is a natural number between 1 and n, and the k^{th} single rack is any single rack of the energy storage system except for the target single rack; and
controlling, by the SBMU of the k^{th} single rack, the wake-up relay (103, n03) of the k^{th} single rack to be closed, so that the CSC module of the k^{th} single rack starts to work after being awakened, thereby completing start-up of the k^{th} single rack.

9. The method according to claim 8, wherein the energy storage system is configured according to claim 2,

and wherein the method further comprises:
performing, by the slave battery management unit (SBMU) of the target single rack, detection on a switching status of the first miniature circuit breaker (101, n01) of the target single rack; if it is detected that the first miniature circuit breaker (101, n01) of the target single rack is not opened, controlling, by the slave battery management unit (SBMU) of the target single rack after preset time, the release relay (107, n07) of the target single rack to be closed; and performing, by a release (106, n06) of the target single rack after the release (106, n06) is energized, an action of opening the first miniature circuit breaker (101, n01) of the target single rack.

10. The method according to claim 8 or 9, wherein the method further comprises:
when an x^{th} single rack triggers over-discharge protection, controlling, by a slave battery management unit (SBMU) of the x^{th} single rack, the main positive high voltage relay (104, n04) of the x^{th} single rack and the main negative high voltage relay (105, n05) of the x^{th} single rack to be opened first, and then the wake-up relay (103, n03) of the x^{th} single rack to be opened, wherein the x^{th} single rack is any single rack of the energy storage system.

Patentansprüche

1. Energiespeichersystem, wobei das System aufweist:

ein Stromumwandlungssystem, PCS, zum Umwandeln von elektrischer Energie aus Photovoltaik-, PV, oder Windenergie;
einen Gleichstrom-Bus, der an das PCS angeschlossen ist, um das PCS zu bestromen;
n Einzelracks, wobei n eine natürliche Zahl ist und n größer gleich 1 ist;
einen Host-Computer, der mit jedem der n Einzelracks verbunden ist; und
eine Batterie-Hauptmanagementeinheit, die mit jedem der n Einzelracks verbunden ist, wobei jedes der n Einzelracks einen ersten Miniatur-Leistungsschalter (101, n01), ein DC/DC-Leistungsmodul, eine Slave-Batteriemanagementeinheit, SBMU, ein Weckrelais (103, n03), ein Hauptrelais für positive Hochspannung (104, n04), ein Hauptrelais für negative Hochspannung (105, n05), eine Cell Supervisory Circuit, CSC,-Modul und einen Batteriekasten, der eine Batteriegruppe und eine positive und eine negative Elektrode aufweist, aufweist,
wobei in jedem der n Einzelracks:

das DC/DC-Leistungsmodul mit dem DC-Bus (10) verbunden ist, um Strom von dem DC-Bus (10) zu erhalten;
das DC/DC-Leistungsmodul über den ersten Miniatur-Leistungsschalter (101, n01) mit der in dem Batteriekasten enthaltenen Batteriegruppe verbunden und konfiguriert ist, Leistung von der Batteriegruppe aufzunehmen, wenn der erste Miniatur-Leistungsschalter (101, n01) geschlossen ist;
das DC/DC-Leistungsmodul mit der SMBU, dem Host-Computer und der MBMU verbunden und konfiguriert ist, jedem von diesen Leistung bereitzustellen, wenn das DC/DC-Leistungsmodul über den ersten Miniatur-Leistungsschalter (101, n01) Leistung von der in der Batteriebox enthaltenen Batteriegruppe aufnimmt,
beim Aufnehmen von Leistung von dem DC/DC-Leistungsmodul die SMBU konfiguriert ist, das Weckrelais (103, n03) zu schließen, um das DC/DC-Leistungsmodul über das Weckrelais (103, n03) and die CSC anzuschließen, um der CSC Leistung bereitzustellen;
das Hauptrelais für positive Hochspannung (104, n04) an die positive Elektrode der in dem Batteriekasten enthaltenen Batteriegruppe angeschlossen ist und das Hauptrelais für negative Hochspannung (105, n05) an die negative Elektrode der in dem Batteriekasten enthaltenen Batteriegruppe angeschlossen ist, wobei der Host-Computer bei der Aufnahme von Leistung von dem DC/DC-Leistungsmodul konfiguriert ist, das Hauptrelais für positive Hochspannung (104, n04) und das Hauptrelais für negative Hochspannung (105, n05) zu schließen, und wobei der Batteriekasten konfiguriert ist, um dem Gleichstrom-Bus über das geschlossene Hauptrelais für positive Hochspannung (104, n04) und das geschlossene Hauptrelais für negative Hochspannung (105, n05) Leistung bereitzustellen.

2. System nach Anspruch 1, wobei jedes der n Einzelracks ferner aufweist:

eine Freischaltung (106; n106) und
ein Freischaltungsrelais (107, n07), das jeweils mit dem DC/DC-Leistungsmodul und der Freischaltung (106, n06) verbunden ist, wobei das Freischaltungsrelais von der Slave-Batteriemanagementeinheit (SBMU) dahingehend steuerbar ist, geschlossen zu werden und wobei die Freischaltung konfiguriert ist, einen Vorgang des Öffnens des ersten Miniatur-Leistungsschalters (101, n01) durchzuführen, wenn das Freischaltungsrelais unter Steuerung der

(SBMU) geschlossen wird.

3. System nach Anspruch 1, wobei jedes der n Einzelracks ferner aufweist:
einen zweiten Miniatur-Leistungsschalter (102, n02), dessen eines Ende mit dem Stromumwandlungssystem (PCS) und dessen anderes Ende mit dem DC/DC-Leistungsmodul verbunden ist.

4. System nach einem der Ansprüche 1 bis 3, wobei das System ferner aufweist: einen Haupttrennschalter (20), dessen eines Ende mit dem Stromumwandlungssystem und dessen anderes Ende mit jedem der n Einzelracks verbunden ist.

5. System nach Anspruch 4, wobei jedes der n Einzelracks ferner aufweist:

einen Leistungsschalter(110, n10), dessen eines Ende mit dem Haupttrennschalter (20) und dessen anderes Ende mit einem Trennschalter (109, n109) verbunden ist; und
den Trennschalter (109, n09), dessen eines Ende mit dem Leistungsschalter (110, n10) verbunden ist und dessen anderes Ende sowohl mit dem Hauptrelais für positive Hochspannung (104, n04) als auch mit dem Hauptrelais für negative Hochspannung (105, n05) verbunden ist.

6. System nach Anspruch 5, wobei jedes der n einzelnen Racks ferner aufweist: ein Hochspannungs-Vorladerelais (108, n08) und einen Vorladewiderstand (113, n13), wobei das Hochspannungs-Vorladerelais (108, n08) mit dem Vorladewiderstand (113, n13) in Reihe geschaltet ist und dann das Hochspannungs-Vorladerelais (108, n08) und der Vorladewiderstand (113, n13), die in Reihe geschaltet sind, mit dem Hauptrelais für positive Hochspannung (104, n04) parallelgeschaltet werden.

7. System nach Anspruch 1, wobei jedes der n einzelnen Racks ferner aufweist:
eine Sicherung (111, n11), die in den Anschluss zwischen dem Hauptrelais für positive Hochspannung (104, n04) und die positive Elektrode der in dem Batteriekasten enthaltenen Batteriegruppen zwischengeschaltet ist.

8. Selbststartverfahren eines Energiespeichersystems nach Anspruch 1, wobei das Verfahren umfasst:

Schließen eines ersten Miniatur-Leistungsschalters (10, n01)eines Ziel-Einzelracks, so dass ein DC/DC-Leistungsmodul des Ziel-Einzelracks bestromt wird und Strom an eine Batterie-Hauptmanagementeinheit, MBMU, den Host-Computer und eine Slave-Batteriemanagementeinheit, SBMU des Ziel-Einzelracks ausgibt, wobei das Zieleinzelrack ein Einzelrack des Energiespeichersystems ist, das eine voreingestellte Bedingung erfüllt;
Steuern, dass ein Weckrelais des Ziel-Einzelracks durch die Slave-Batteriemanagementeinheit des Ziel-Einzelracks geschlossen wird, durch die SBMU, so dass das Cell Supervisory Circuit, CSC-, Modul des Ziel-Einzelracks nach dem Aufwecken zu arbeiten beginnt und dadurch den Startvorgang des Ziel-Einzelracks abschließt;
Steuern, durch den Host-Computer, des Hauptrelais für positive Hochspannung (104, n04) und des Hauptrelais für negative Hochspannung (105, n05), dahingehend, geschlossen zu werden, so dass das das Ziel-Einzelrack mit Hochspannung eingeschaltet wird, wodurch ein DC-Bus mit Strom versorgt wird und das Stromumwandlungssystem, PCS, bestromt wird;
Empfangen, durch das DC/DC-Leistungsmodul, von Strom vom DC-Bus eines k^{ten} Einzelracks und Ausgeben des Stroms an die SBMU des k^{ten} Einzelracks, wobei k eine natürliche Zahl zwischen 1 und n ist und das k^{te} Einzelrack ist ein beliebiges Einzelrack des Energiespeichersystems mit Ausnahme des Ziel-Einzelracks ist; und
Steuern, durch die SBMU des k^{ten} Einzelracks, des Weckrelais (103, n03) des k^{ten} Einzelracks, so dass dieses geschlossen wird, so dass das CSC-Modul des k^{ten} Einzelracks seine Arbeit aufnimmt, nachdem es aufgeweckt wurde, wodurch das Hochfahren des k^{ten} Einzelracks abgeschlossen wird.

9. Verfahren nach Anspruch 8, wobei das Energiespeichersystem gemäß Anspruch 2 konfiguriert ist und wobei das Verfahren ferner umfasst:
Durchführen des Detektierens eines Schaltzustands des ersten Miniatur-Leistungsschalter (101, n01) des Ziel-Einzelracks; wenn detektiert wird, dass der erste Miniatur-Leistungsschalter (101, n01) des Ziel-Einzelracks nicht geöffnet ist, Steuern, durch die Slave-Batteriemanagementeinheit, SBMU, des Ziel-Einzelracks nach einer voreingestellten Zeit, des Freischaltungsrelais (107, n07), des Ziel-Einzelracks dahingehend, geschlossen zu werden; und Durchführen, durch ein Freischalten (106, n06) des Ziel-Einzelracks, das nach der Freischaltung (106, n06) bestromt wird, eines Vorgangs des Öffnens des ersten Miniatur-Leistungsschalters (101, n01) des Ziel-Einzelracks.

10. Verfahren nach Anspruch 8 oder 9, wobei das Verfahren ferner umfasst:
wenn ein x-tes Einzelrack den Over-Discharge-Schutz auslöst, Steuern des x^{ten} Einzelracks, des Hauptrelais für positive Hochspannung (104, n04)

des x^{ten} Einzelracks und des Hauptrelais für negative Hochspannung (105, n05), des x^{ten} Einzelracks, durch eine Slave-Batteriemanagementeinheit (SBMU), so dass diese zuerst geöffnet werden, und dass dann das Weckrelais (103, n03) des x^{ten} Einzelracks geöffnet wird, wobei das x^{te} Einzelrack ein beliebiges Einzelrack des Energiespeichersystems ist.

Revendications

1. Système de stockage d'énergie, dans lequel le système comprend :

un système de conversion de puissance (PCS) destiné à convertir de l'énergie électrique à partir d'énergie photovoltaïque (PV) ou éolienne,
une barre omnibus à courant continu connectée au PCS pour alimenter le PCS en énergie ;
n armoires électriques individuelles, dans lequel n est un nombre naturel et n est supérieur à 1 ;
un ordinateur hôte connecté à chacune des n armoires électriques individuelles ; et
une unité de gestion de batterie maître (MBMU) connectée à chacune des n armoires électriques individuelles, dans lequel
chacune des n armoires électriques individuelles comprend un premier micro-disjoncteur (101, n01), un module de puissance CC/CC, une unité de gestion de batterie esclave (SBMU), un relais d'activation (103, n03), un relais à haute tension positive principal (104, n04), un relais à haute tension négative principal (105, n05), un module à circuit de supervision de cellule (CSC), et un boîtier de batterie comportant un groupe de batteries et comprenant une électrode positive et une électrode négative,
dans lequel dans chacune des n armoires électriques individuelles :

le module de puissance CC/CC est connecté à la barre omnibus à courant continu (10) pour recevoir de la puissance provenant de la barre omnibus à courant continu (10),
le module de puissance CC/CC est connecté au groupe de batteries compris dans le boîtier de batterie par l'intermédiaire du premier micro-disjoncteur (101, n01) et est configuré pour recevoir de la puissance provenant du groupe de batterie lorsque le premier micro-disjoncteur (101, n01) est fermé ;
le module de puissance CC/CC est connecté à la SBMU, à l'ordinateur hôte et à la MBMU et est configuré pour fournir de la puissance à chacun d'eux lorsque le module de puissance CC/CC reçoit de la puissance du groupe de batteries compris dans le boîtier de batterie par l'intermédiaire du premier micro-disjoncteur (101, n01) fermé,
la SBMU est, lorsqu'elle reçoit de la puissance du module de puissance CC/CC, configurée pour fermer le relais d'activation (101, n03) pour connecter le module de puissance CC/CC au module CSC par l'intermédiaire du relais d'activation (103, n03) pour fournir de la puissance au CSC ;
le relais à haute tension positive principal (104, n04) est connecté à l'électrode positive du groupe de batteries compris dans le boîtier de batterie, et le relais à haute tension négative principal (105, n05) est connecté à l'électrode négative du groupe de batteries compris dans le boîtier de batterie,
dans lequel l'ordinateur hôte est, lorsqu'il reçoit de la puissance provenant du module de puissance CC/CC, configuré pour fermer le relais à haute tension positive principal (104, n04) et le relais à haute tension négative principal (104, n05), et dans lequel le boîtier de batterie est configuré pour fournir de la puissance à la barre omnibus à courant continu par l'intermédiaire du relais à haute tension positive principal (104, n04) fermé et du relais à haute tension négative principal (104, n05) fermé.

2. Système selon la revendication 1, dans lequel chacune des n armoires électriques individuelles comprend en outre :

une temporisation (106, n06) ; et
un relais de temporisation (107, n07) connecté à chacun du module de puissance CC/CC et de la temporisation (106, n06), dans lequel le relais de temporisation peut être commandé par l'unité de gestion de batterie esclave (SBMU) pour être fermé, et dans lequel la temporisation est configurée pour réaliser une action d'ouverture du premier micro-disjoncteur (101, n01) lorsque le relais de temporisation est fermé sous la commande de la SBMU.

3. Système selon la revendication 1, dans lequel chacune des n armoires électriques individuelles comprend en outre :
un deuxième micro-disjoncteur (102, n02), dont une extrémité est connectée au système de conversion de puissance (PCS) et dont l'autre extrémité est connectée au module de puissance CC/CC.

4. Système selon l'une quelconque des revendications 1 à 3, dans lequel le système comprend en outre :
un commutateur d'isolation principal (20), dont une extrémité est connectée au système de conversion

de puissance et dont l'autre extrémité est connectée à chacune des n armoires électriques individuelles.

5. Système selon la revendication 4, dans lequel chacune des n armoires électriques individuelles comprend en outre :

un disjoncteur (110, n10), dont une extrémité est connectée au commutateur d'isolation principal (20) et dont l'autre extrémité est connectée à un commutateur d'isolation (109, n09), et
le commutateur d'isolation (109, n09) dont une extrémité est connectée au disjoncteur (110, n10) et dont l'autre extrémité est connectée à la fois au relais à haute tension positive principal (104, n04) et au relais à haute tension négative principal (105, n05).

6. Système selon la revendication 5, dans lequel chacune des n armoires électriques individuelles comprend en outre :
un relais de précharge à haute tension (108, n08) et une résistance de précharge (113, n13), dans lequel le relais de précharge à haute tension (108, n08) est connecté en série à la résistance de précharge (113, n13), puis le relais de précharge à haute tension (108, n08) et la résistance de précharge (113, n13) en connexion en série sont connectés en parallèle avec le relais à haute tension positive principal (104, n04).

7. Système selon la revendication 1, dans lequel chacune des n armoires électriques individuelles comprend en outre :
un fusible (111, n11), qui est interconnecté dans la connexion entre le relais à haute tension positive principal (104, n04) et l'électrode positive du groupe de batteries compris dans le boîtier de batterie.

8. Procédé de démarrage automatique d'un système de stockage d'énergie selon la revendication 1, dans lequel le procédé comprend :

la fermeture du premier micro-disjoncteur (101, n01) d'une armoire électrique individuelle cible de telle sorte que le module de puissance CC/CC de l'armoire électrique individuelle cible est alimenté en énergie et délivre une puissance à l'unité de gestion de batterie maître (MBMU), à l'ordinateur hôte et à l'unité de gestion de batterie esclave (SBMU) de l'armoire électrique individuelle cible, dans lequel l'armoire électrique individuelle cible est une armoire électrique individuelle du système de stockage d'énergie répondant à une condition prédéfinie ;
la commande, par la SBMU, de l'armoire électrique individuelle cible,
un relais d'activation (103, n03) de l'armoire électrique individuelle cible à fermer de telle sorte que le module de circuit de supervision de cellule (CSC) de l'armoire électrique individuelle cible commence à fonctionner après avoir été activé en réalisant ainsi le démarrage de l'armoire électrique individuelle cible ;
la commande, par l'ordinateur hôte, du relais à haute tension positive principal (104, n04) et du relais à haute tenson négative principal (105, n05) à fermer de telle sorte que l'armoire électrique individuelle cible soit alimentée en énergie à haute tension, alimentant ainsi la barre omnibus à courant continu (10), et du système de conversion de puissance (PCS) à alimenter en énergie ;
la réception, par le module de puissance CC/CC d'une $k^{ième}$ armoire électrique individuelle unique, de puissance de la barre omnibus à courant continu (10), et la délivrance en sortie de la puissance à la SBMU de la $k^{ième}$ armoire électrique individuelle, dans lequel k est un nombre naturel entre 1 et n, et la $k^{ième}$ armoire électrique individuelle est une armoire électrique individuelle du système de stockage d'énergie à l'exception de l'armoire électrique individuelle cible ; et
la commande, par la SBMU, de la $k^{ième}$ armoire électrique individuelle, du relais d'activation (103, n03) de la $k^{ième}$ armoire électrique individuelle à fermer de telle sorte que le module CSC de la $k^{ième}$ armoire électrique individuelle commence à fonctionner après avoir été activé, en réalisant ainsi le démarrage de la $k^{ième}$ armoire électrique individuelle.

9. Procédé selon la revendication 8, dans lequel le système de stockage d'énergie est configuré selon la revendication 2, et dans lequel le procédé comprend en outre :
la réalisation, par l'unité de gestion de batterie esclave (SBMU) de l'armoire électrique individuelle cible, de la détection d'un statut de commutation du premier micro-disjoncteur (101, n01) de l'armoire électrique individuelle cible ; s'il est détecté que le premier micro-disjoncteur (101, n01) de l'armoire électrique individuelle cible n'est pas ouvert, la commande, par l'unité de gestion de batterie esclave (SBMU), de l'armoire électrique individuelle cible après une durée prédéfinie, du relais de temporisation (107, n07) de l'armoire électrique individuelle cible à fermer ; et la réalisation, par une temporisation (106, 06) de l'armoire électrique individuelle cible après l'alimentation en énergie de la temporisation (106, n06), d'une action d'ouverture du premier micro-disjoncteur (101, n01) de l'armoire électrique individuelle cible.

10. Procédé selon la revendication 8 ou 9, dans lequel le procédé comprend en outre :

lorsqu'une $x^{ième}$ armoire électrique individuelle déclenche une protection contre une décharge excessive, la commande, par une unité de gestion de batterie esclave (SBMU) de la $x^{ième}$ armoire électrique individuelle, du relais à haute tension positive principal (104, n04) de la $x^{ième}$ armoire électrique individuelle et du relais à haute tension négative principal (105, n05) de la $x^{ième}$ armoire électrique individuelle à ouvrir en premier, puis du relais d'activation (103, n03) de la $x^{ième}$ armoire électrique individuelle à ouvrir, dans lequel la $x^{ième}$ armoire électrique individuelle est une armoire électrique individuelle quelconque du système de stockage d'énergie.

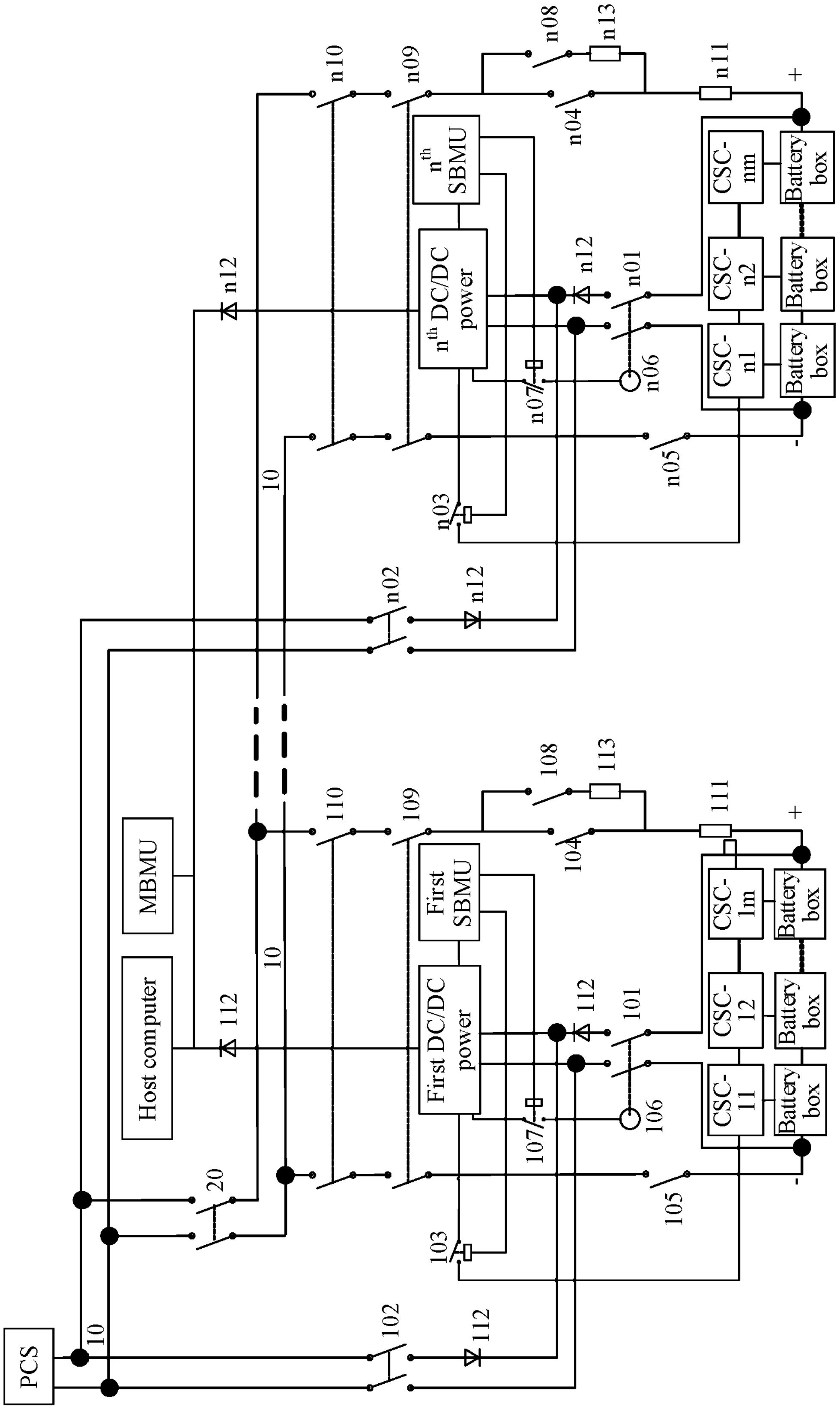
PCS
10
102
112
20
Host computer
MBMU
110
109
First DC/DC power
First SBMU
108
113
111
104
101
106
107
103
105
CSC-11
CSC-12
CSC-1m
Battery box
+
-
n02
n12
n10
n09
n^th DC/DC power
n^th SBMU
n08
n13
n11
n04
n01
n06
n07
n03
n05
CSC-n1
CSC-n2
CSC-nm

FIG. 1

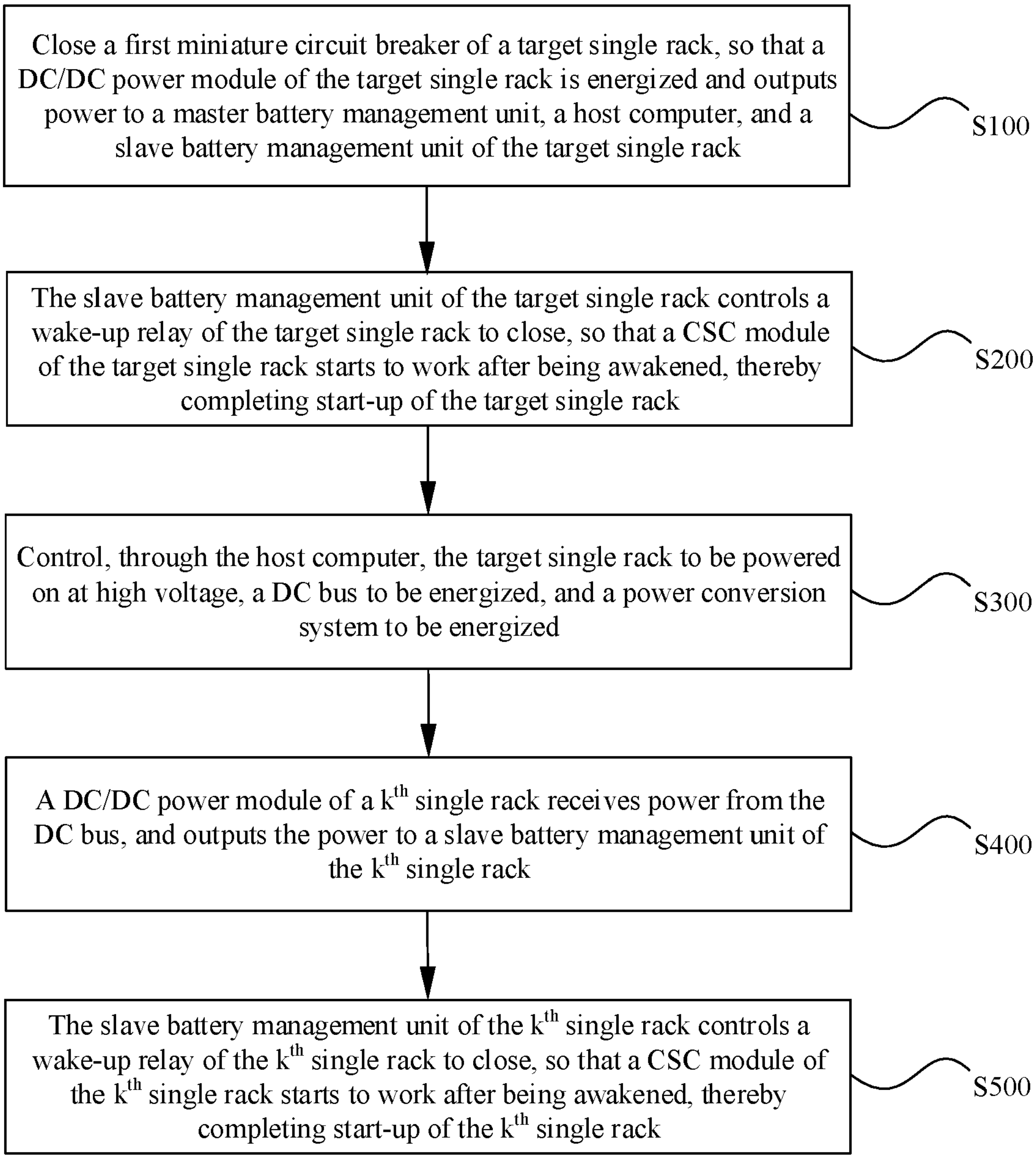
Close a first miniature circuit breaker of a target single rack, so that a DC/DC power module of the target single rack is energized and outputs power to a master battery management unit, a host computer, and a slave battery management unit of the target single rack
S100
The slave battery management unit of the target single rack controls a wake-up relay of the target single rack to close, so that a CSC module of the target single rack starts to work after being awakened, thereby completing start-up of the target single rack
S200
Control, through the host computer, the target single rack to be powered on at high voltage, a DC bus to be energized, and a power conversion system to be energized
S300
A DC/DC power module of a kth single rack receives power from the DC bus, and outputs the power to a slave battery management unit of the kth single rack
S400
The slave battery management unit of the kth single rack controls a wake-up relay of the kth single rack to close, so that a CSC module of the kth single rack starts to work after being awakened, thereby completing start-up of the kth single rack
S500

FIG. 2

REFERENCES CITED IN THE DESCRIPTION

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